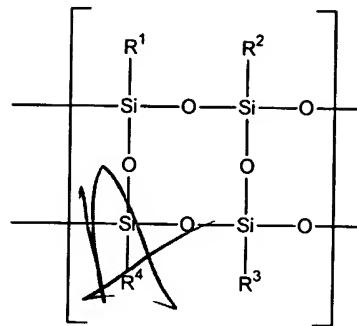


WE CLAIM:

1. A fluorocarbonol functionalized silsesquioxane polymer comprised of monomer units having the structure (I)

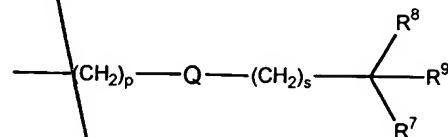
(I)



wherein,

R¹, R², R³ and R⁴ are independently selected from the group consisting of substituents having structure (II)

(II)



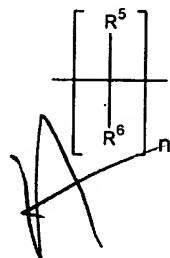
wherein

p is 0, 1, or 2,

~~s is 0, 1, or 2,~~

~~Q is selected from the group consisting of substituted and unsubstituted arylene, substituted and unsubstituted cycloalkylene, substituted and unsubstituted alkaryl, and moieties having the structure (III)~~

~~(III)~~



~~wherein R⁵ and R⁶ are independently hydrogen, alkyl or fluoroalkyl and n is an integer from 1 to 4,~~

~~R⁷ is hydrogen, alkyl or fluoroalkyl,~~

~~R⁸ is linear or branched fluoroalkyl, and~~

~~R⁹ is OH, COOH or an acid-cleavable moiety.~~

2. The polymer of claim 1, wherein R⁹ is OH.

3. The polymer of claim 1, wherein R⁹ is an acid-cleavable moiety.

- 1
4. The polymer of claim 3, wherein R⁹ is selected from the group consisting of esters, carbonates, and ethers.
5. The polymer of claim 4, wherein R⁹ is an ester.
6. The polymer of claim 5, wherein R⁹ has the formula -(L)_v-(CO)-O R¹⁴ wherein v is zero or 1, L is a linking group, and R¹⁴ is selected from the group consisting of tertiary alkyl moieties, cyclic or alicyclic substituents with a tertiary attachment point, and 2-trialkylsilyleethyl moieties.
7. The polymer of claim 6, wherein v is zero and R¹⁴ is tertiary alkyl.
8. The polymer of claim 7, wherein R¹⁴ is *t*-butyl.
9. The polymer of claim 6, wherein v is zero and R¹⁴ is a cyclic or alicyclic substituent with a tertiary attachment point.
10. The polymer of claim 9, wherein R¹⁴ is selected from the group consisting of adamantyl, norbornyl, isobornyl, 2-methyl-2-adamantyl, 2-methyl-2-isobornyl, 2-methyl-2-

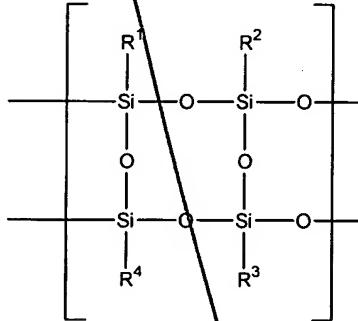
tetracyclododecanyl, 2-methyl-2-dihydrodicyclopentadienylcyclohexyl and
1-methylcyclohexenyl.

11. The polymer of claim 6, wherein v is zero and R¹⁴ is 2-trialkylsilylethyl.

12. The polymer of claim 11, wherein R¹⁴ is 2-trimethylsilylethyl.

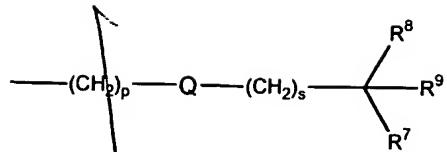
13. A fluorocarbonol functionalized silsesquioxane copolymer comprising monomer units having the structure (I)

(I)



R¹, R², R³ and R⁴ are independently selected from the group consisting of substituents having structure (II)

(II)



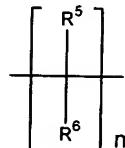
wherein

p is 0, 1, or 2,

s is 0, 1, or 2,

Q is selected from the group consisting of substituted and unsubstituted arylene, substituted and unsubstituted cycloalkylene, substituted and unsubstituted alkarylene, and moieties having the structure (III)

(III)



wherein R⁵ and R⁶ are independently hydrogen, alkyl or fluoroalkyl and n is an integer from 1 to 4,

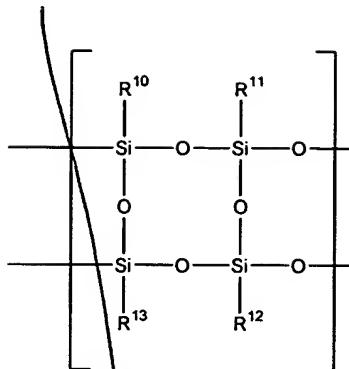
R⁷ is hydrogen, linear or branched alkyl or fluoroalkyl,

R⁸ is linear or branched fluoroalkyl, and

R⁹ is OH, COOH or an acid-cleavable moiety;

and monomer unit having the structure (IV)

(IV)



wherein,

R^{10} , R^{11} , R^{12} and R^{13} are independently hydrogen, alkyl, fluoroalkyl, fluorocarbinol or an acid-cleavable moiety, with the proviso that at least one of R^{10} , R^{11} , R^{12} and R^{13} is an acid-cleavable moiety.

A

14. The copolymer of claim 13, wherein R^9 is OH.

15. The copolymer of claim 13, wherein at least one acid-cleavable moiety in the monomer having structure IV is selected from the group consisting of esters, ethers, and carbonates.

16. The copolymer of claim 15, wherein at least one acid-cleavable moiety in the monomer having structure IV is an ester.

17. The copolymer of claim 16, wherein the ester has the formula -(L)_v-(CO)-OR¹⁴ wherein v is zero or 1, L is a linking group, and R¹⁴ is selected from the group consisting of tertiary alkyl moieties, cyclic and alicyclic substituents with a tertiary attachment point, and 2-trialkylsilylalkyl moieties.
18. The copolymer of claim 17, wherein v is zero and R¹⁴ is tertiary alkyl.
19. The copolymer of claim 18, wherein R¹⁴ is *t*-butyl.
20. The copolymer of claim 17, wherein v is zero and R¹⁴ is a cyclic or alicyclic substituent with a tertiary attachment point.
21. The copolymer of claim 20, wherein R¹⁴ is selected from the group consisting of adamantlyl, norbornyl, isobornyl, 2-methyl-2-adamantlyl, 2-methyl-2-isobornyl, 2-methyl-2-tetracyclododecanyl, 2-methyl-2-dihydrodicyclopentadienylcyclohexenyl and 1-methylcyclohexenyl.
22. The copolymer of claim 17, wherein v is zero and R¹⁴ is 2-trialkylsilylalkyl.
23. The copolymer of claim 22, wherein R¹⁴ is 2-trimethylsilylalkyl.

24. The copolymer of claim 17, wherein v is 1, L is a norbornyl or a cyclohexylene group, and R¹⁴ is tertiary alkyl.

25. The copolymer of claim 24, wherein R¹⁴ is *t*-butyl.

25. The copolymer of claim 24, wherein R¹⁴ is a cyclic or alicyclic substituent with a tertiary attachment point.

26. The copolymer of claim 25, wherein R¹⁴ is selected from the group consisting of adamantyl, norbornyl, isobornyl, 2-methyl-2-adamantyl, 2-methyl-2-isobornyl, 2-methyl-2-tetracyclododeceny, 2-methyl-2-dihydrodicyclopentadienylcyclohexenyl and 1-methylcyclohexenyl.

27. The copolymer of claim 24, wherein R¹⁴ is 2-trialkylsilylethyl.

28. The copolymer of claim 27, wherein R¹⁴ is 2-trimethylsilylethyl.

29. The polymer of claim 1, wherein R⁸ is perfluorinated lower alkyl.

30. The polymer of claim 29, wherein R⁸ is trifluoromethyl.

31. The copolymer of claim 13, wherein R⁸ is perfluorinated lower alkyl..

32. The copolymer of claim 31, wherein R⁸ is trifluoromethyl.

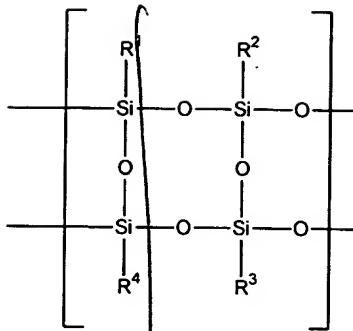
33. The polymer of claim 1, wherein R⁹ is -COOH.

34. The copolymer of claim 13, wherein R⁹ is -COOH.

35. The copolymer of claim 13, wherein R⁹ is an acid-cleavable functionality.

36. In a lithographic photoresist composition comprised of a polymer transparent to deep ultraviolet radiation and a radiation-sensitive acid generator, the improvement comprising employing as the polymer a polymer comprised of a fluorocarbinol functionalized silsesquioxane monomer units having the structure (I)

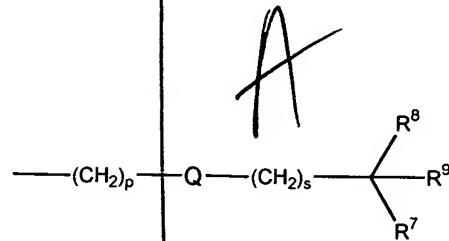
(I)



wherein

R¹, R², R³ and R⁴ are independently selected from the group consisting of substituents having structure (II)

(II)



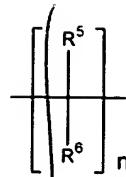
wherein

p is 0, 1, or 2,

s is 0, 1, or 2,

Q is selected from the group consisting of substituted and unsubstituted arylene, substituted and unsubstituted cycloalkylene, substituted and unsubstituted alkarylene, and moieties having the structure (III)

(III)



wherein R⁵ and R⁶ are independently hydrogen, alkyl or fluoroalkyl and n is an integer from 0 to 4,

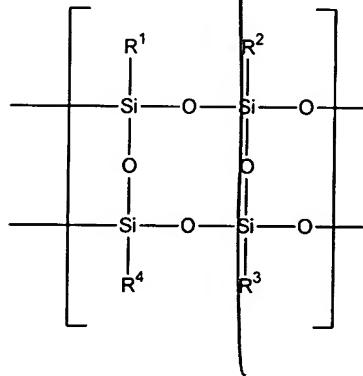
R⁷ is hydrogen, linear or branched alkyl or fluoroalkyl,

R⁸ is linear or branched fluoroalkyl, and

R⁹ is OH, COOH or an acid-cleavable moiety.

37. In a lithographic photoresist composition comprised of a polymer transparent to deep ultraviolet radiation and a radiation-sensitive acid generator, the improvement which comprises employing as the polymer a copolymer comprised of a monomer unit having the structure (I)

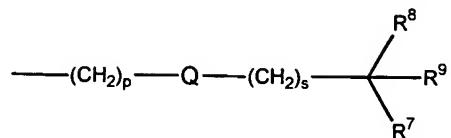
(I)



wherein,

R^1, R^2, R^3 and R^4 are independently selected from the group consisting of
substituents having structure (II)

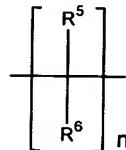
(II)



wherein

, and moieties having the structure (III)

(III)



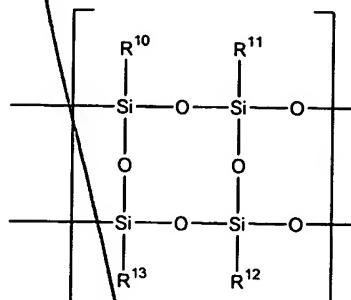
wherein R^5 and R^6 are independently hydrogen, alkyl or fluoroalkyl and n is
an integer from 0 to 4,

R^7 is hydrogen, linear or branched alkyl or fluoroalkyl,

R^8 is linear or branched fluoroalkyl, and

R⁹ is OH, COOH or an acid-cleavable moiety;
and a monomer unit having the structure (IV)

(IV)



wherein,

R¹⁰, R¹¹, R¹² and R¹³ are independently hydrogen, alkyl, fluoroalkyl, fluorocarbinol, fluoroacid, or an acid-cleavable moiety, with the proviso that at least one of R¹⁰, R¹¹, R¹² and R¹³ is an acid-cleavable moiety.

38. The lithographic photoresist composition of claim 36, wherein R⁹ is OH.

39. The lithographic photoresist composition of claim 36, wherein the photoresist composition is a positive resist and further comprises a photoacid-cleavable monomeric or polymeric dissolution inhibitor.

40. The lithographic photoresist composition of claim 37, wherein the photoresist composition is a positive resist and further comprises a photoacid-cleavable monomer or polymeric dissolution inhibitor.

41. The lithographic photoresist composition of claim 38, wherein the photoresist composition is a positive resist and further comprises a photoacid-cleavable monomer or polymeric dissolution inhibitor.

42. The lithographic photoresist composition of claim 38, wherein the photoresist composition is a negative resist and further comprises a crosslinking agent.

43. The lithographic photoresist composition of claim 42, wherein the crosslinking agent is a glycoluril compound.

44. The lithographic photoresist composition of claim 43, wherein the glycoluril compound is selected from the group consisting of tetramethoxymethyl glycoluril, methylpropyltetramethoxymethyl glycoluril, methylphenyltetramethoxymethyl glycoluril, and mixtures thereof.

45. A process for generating a resist image on a substrate, comprising the steps of:
- (a) coating a substrate with a film of a photoresist composition comprised of:
 - (i) the polymer of claim 1; and
 - (ii) a radiation-sensitive acid generator;
 - (b) exposing the film selectively to a predetermined pattern of deep ultraviolet radiation so as to form a latent, patterned image in the film; and
 - (c) developing the latent image with a developer.
46. A process for generating a resist image on a substrate, comprising the steps of:
- (a) coating a substrate with a film of a photoresist composition comprised of:
 - (i) the copolymer of claim 11; and
 - (ii) a radiation-sensitive acid generator;
 - (b) exposing the film selectively to a predetermined pattern of deep ultraviolet radiation so as to form a latent, patterned image in the film; and
 - (c) developing the latent image with a developer.

47. The process of claim 45, wherein the deep ultraviolet radiation has a wavelength of less than 250 nm.

48. The process of claim 46, wherein the deep ultraviolet radiation has a wavelength of less than 250 nm.

49. The process of claim 47, wherein the deep ultraviolet radiation has a wavelength of 157 nm.

50. The process of claim 48, wherein the deep ultraviolet radiation has a wavelength of 157 nm.

51. The process of claim 45, wherein the substrate is a bilayer substrate comprising a base layer covered by an underlayer and the photoresist composition covers the underlayer.

52. The process of claim 46, wherein the substrate is a bilayer substrate comprising a base layer covered by an underlayer and the photoresist composition covers the underlayer.

53. A method of forming a patterned material structure on a substrate, the substrate being selected from the group consisting of semiconductors, ceramics and metals, the method comprising:

(a) optionally providing the substrate with an underlayer, thus forming a bilayer substrate;

- (b) applying a photoresist composition to the substrate or bilayer substrate to form a photoresist layer, said photoresist composition comprising the polymer of claim 1 and a radiation-sensitive acid generator;
- (c) patternwise exposing the substrate to radiation whereby acid is generated by the radiation-sensitive acid generator in exposed regions of the photoresist layer;
- (d) contacting the substrate with an aqueous alkaline developer solution, whereby the exposed regions of the photoresist layer are selectively dissolved by the developer solution to reveal a resist structure pattern; and
- (e) transferring the resist structure pattern to the substrate by etching into the substrate or bilayer substrate through spaces in the resist structure pattern.

54. A method of forming a patterned material structure on a substrate, the substrate being selected from the group consisting of semiconductors, ceramics and metals, the method comprising:

- (a) optionally providing the substrate with an underlayer, thus forming a bilayer substrate;
- (b) applying a photoresist composition to the substrate or underlayer of the bilayer substrate to form a photoresist layer over the material layer, said photoresist composition comprising the copolymer of claim 13 and a radiation-sensitive acid generator;

(c) patternwise exposing the substrate to radiation whereby acid is generated by the radiation-sensitive acid generator in exposed regions of the photoresist layer;

(d) contacting the substrate with an aqueous alkaline developer solution, whereby the exposed regions of the photoresist layer are selectively dissolved by the developer solution to reveal a resist structure pattern; and

(e) transferring the resist structure pattern to the substrate by etching into the substrate or bilayer substrate through spaces in the resist structure pattern.

55. The method of claim 53, wherein the deep ultraviolet radiation has a wavelength of less than 250 nm.

56. The method of claim 54, wherein the deep ultraviolet radiation has a wavelength of less than 250 nm.

57. The method of claim 55, wherein the deep ultraviolet radiation has a wavelength of 157 nm.

58. The method of claim 56, wherein the deep ultraviolet radiation has a wavelength of 157 nm.

59. The method of claim 53, wherein the photoresist composition additionally comprises a photoacid-cleavable monomeric or polymeric dissolution inhibitor.

60. The method of claim 57, wherein R⁹ is OH.

61. The method of claim 54, wherein the photoresist composition additionally comprises a photoacid-cleavable monomeric or polymeric dissolution inhibitor.

62. A method of forming a patterned material structure on a substrate, the material being selected from the group consisting of semiconductors, ceramics and metals, the method comprising:

(a) optionally providing a substrate with an underlayer, thus forming a bilayer substrate;

(b) applying a photoresist composition to the substrate or underlayer of the bilayer substrate to form a photoresist layer over the substrate or bilayer substrate, said photoresist composition comprising the copolymer of claim 2, a crosslinking agent, and a radiation-sensitive acid generator;

(c) patternwise exposing the substrate to radiation whereby acid is generated by the radiation-sensitive acid generator in exposed regions of the photoresist layer thereby causing the crosslinking agent react with the polymer of claim 2;

(d) contacting the substrate with an aqueous alkaline developer solution, whereby the unexposed regions of the photoresist layer are selectively dissolved by the developer solution to reveal a negative resist structure pattern; and

(e) transferring the negative resist structure pattern to the substrate by etching into the substrate or bilayer substrate through spaces in the negative resist structure pattern.

63. The method of claim 62, wherein the deep ultraviolet radiation has a wavelength of less than 250 nm.

64. The method of claim 63, wherein the deep ultraviolet radiation has a wavelength of 157 nm.

65. The method of claim 62, wherein the crosslinking agent is a glycoluril compound.

66. The process of claim 65, wherein the glycoluril compound is selected from the group consisting of tetramethoxymethyl glycoluril, methylpropyltetramethoxymethyl glycoluril, methylphenyltetramethoxymethyl glycoluril, and mixtures thereof.